

# High Performance Ge X-Ray Spectrometers from an Engineer's Point of View

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- **Instrument Design Goals**
  - Solid angle
  - High resolution
  - High count rate
  - Robust
- **Solid angle**
  - Large area detectors
  - Monolithic array
  - Single Be window
- **High resolution**
  - Small geometry, low noise J FETs
  - Low detector capacitance
- **High count rate**
  - Good charge collection
  - High bandwidth preamplifier
  - Low dead time pulse processing electronics

- **Robust**

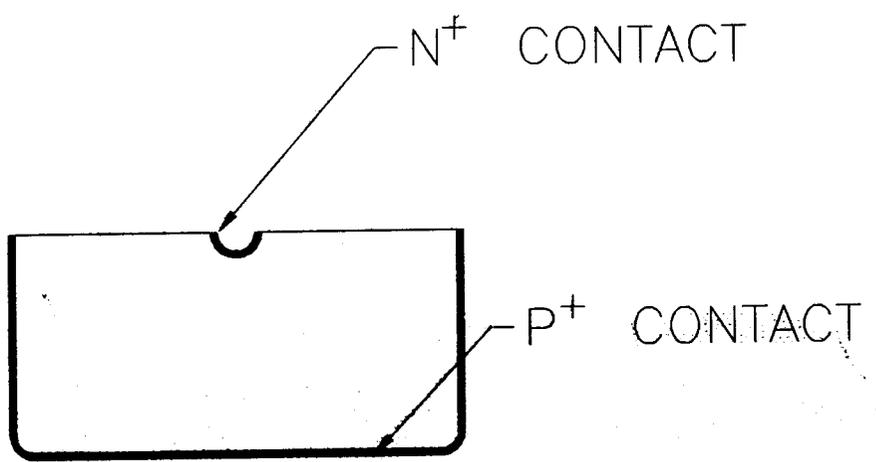
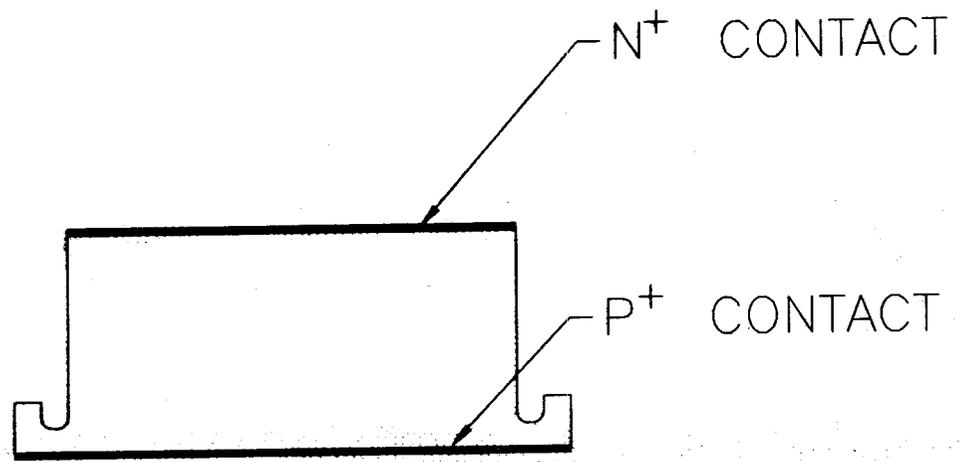
- Insensitive to mechanical shock
- Insensitive to RF ambient
- High stability pulse processing electronics
- Easy to operate

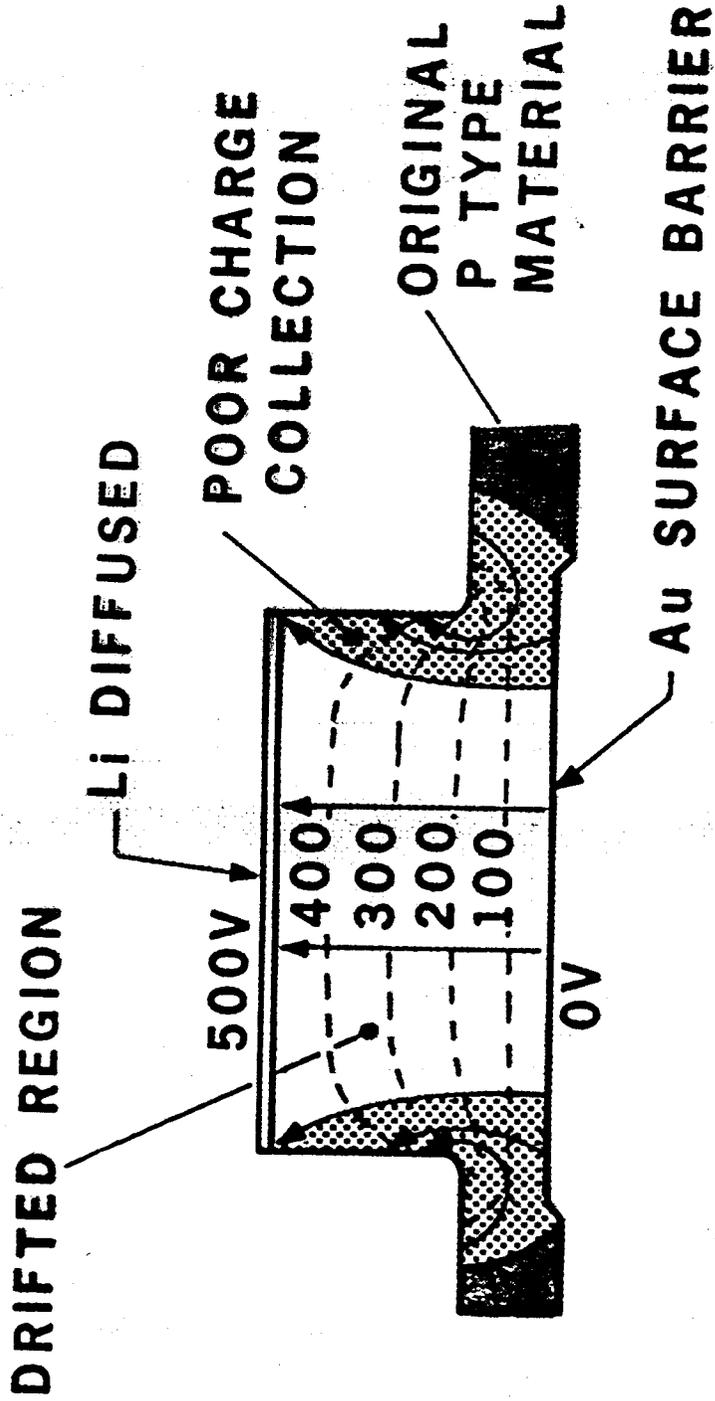
- **Detector Electrode Structures**

- Asymmetric vs. Planar**

- Asymmetric structure has less capacitance
    - Asymmetric structure less susceptible to poor charge collection due to surface state problems ‘Surface Channels’
    - Fabrication of monolithic arrays with low interelectrode capacitance possible
    - Stringent detector material parameters
    - Lower detector yields
    - Monolithic arrays are restricted to regular repetitive patterns

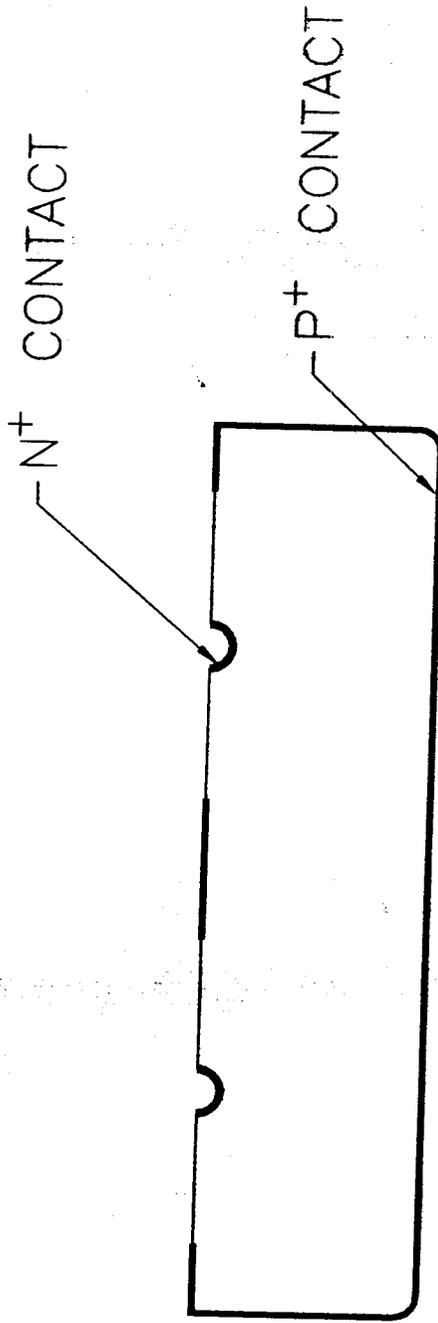
# Ge DETECTOR ELECTRODE GEOMETRY

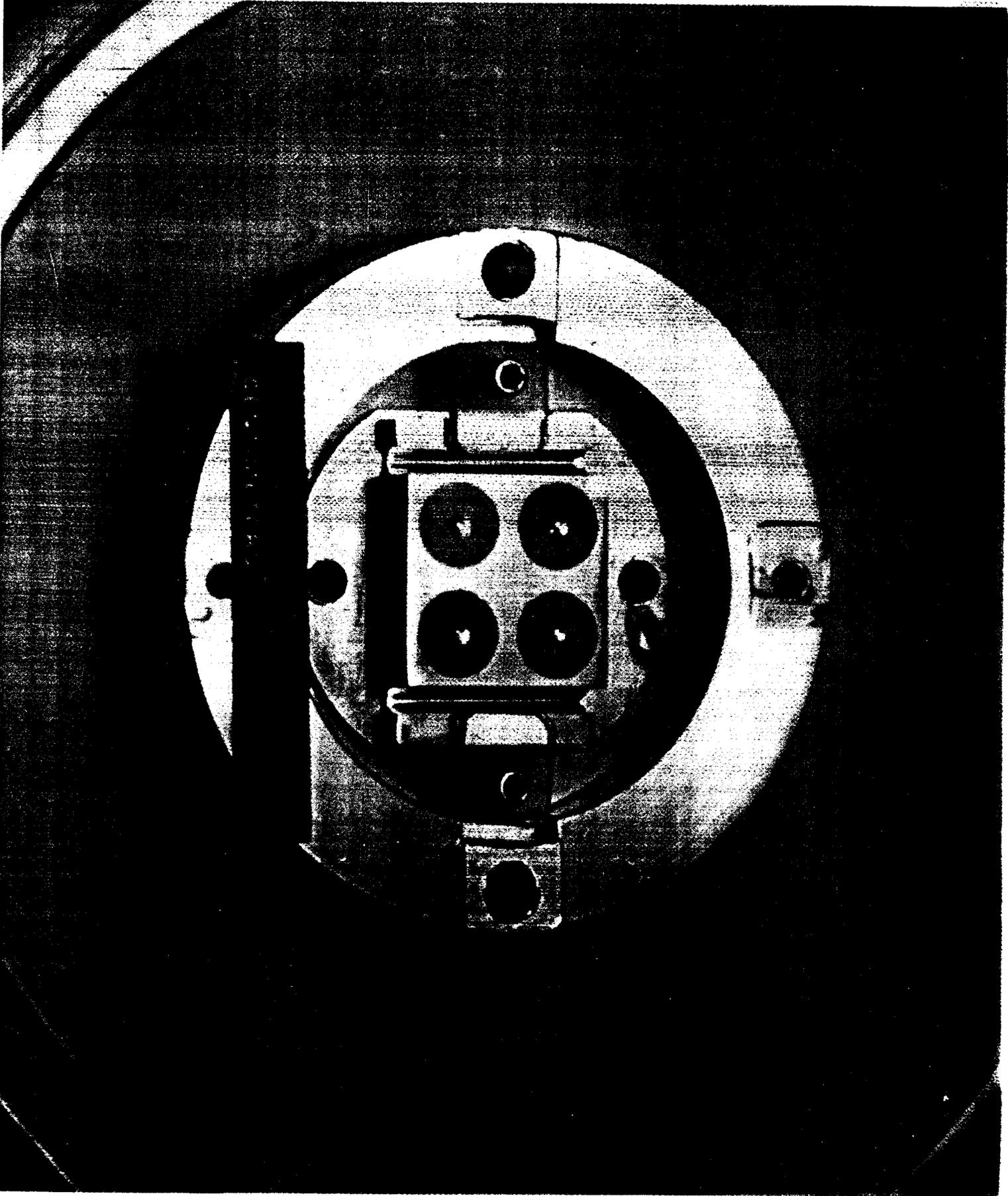




XBL 784-7972

# Ge DETECTOR ELECTRODE GEOMETRY

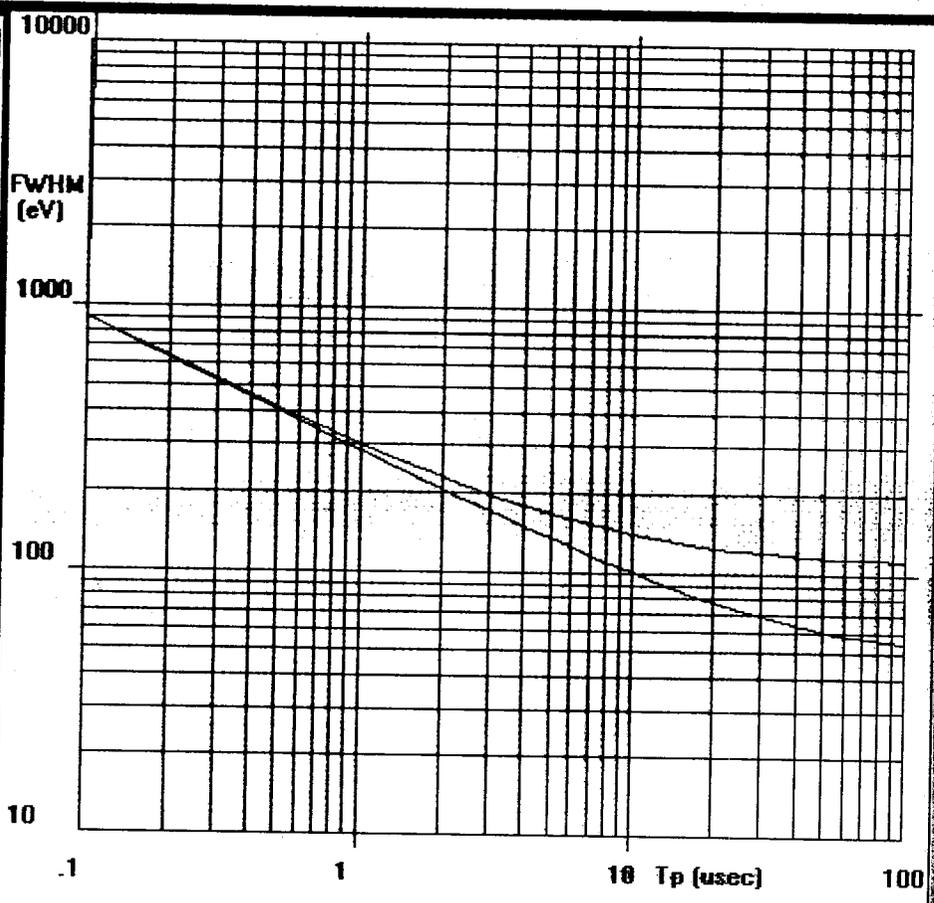




Si or Ge	Ge
Det C (pF)	2.5
Det I (pA)	.01
Fano Factor	.12
Energy (keV)	5.89
FET $G_m$ (mA/V)	6
FET $C_{gs}$ (pF)	1.5
Series R (Mohm)	10
Det. Temp (K)	82
Paral. R (Mohm)	
$A(1/f) \times 1E-14$	

- Shaper
- RC
  - Parabolic
  - Parabolic
  - Parabolic
  - Parabolic
  - Sin
  - Gated
  - User Defined

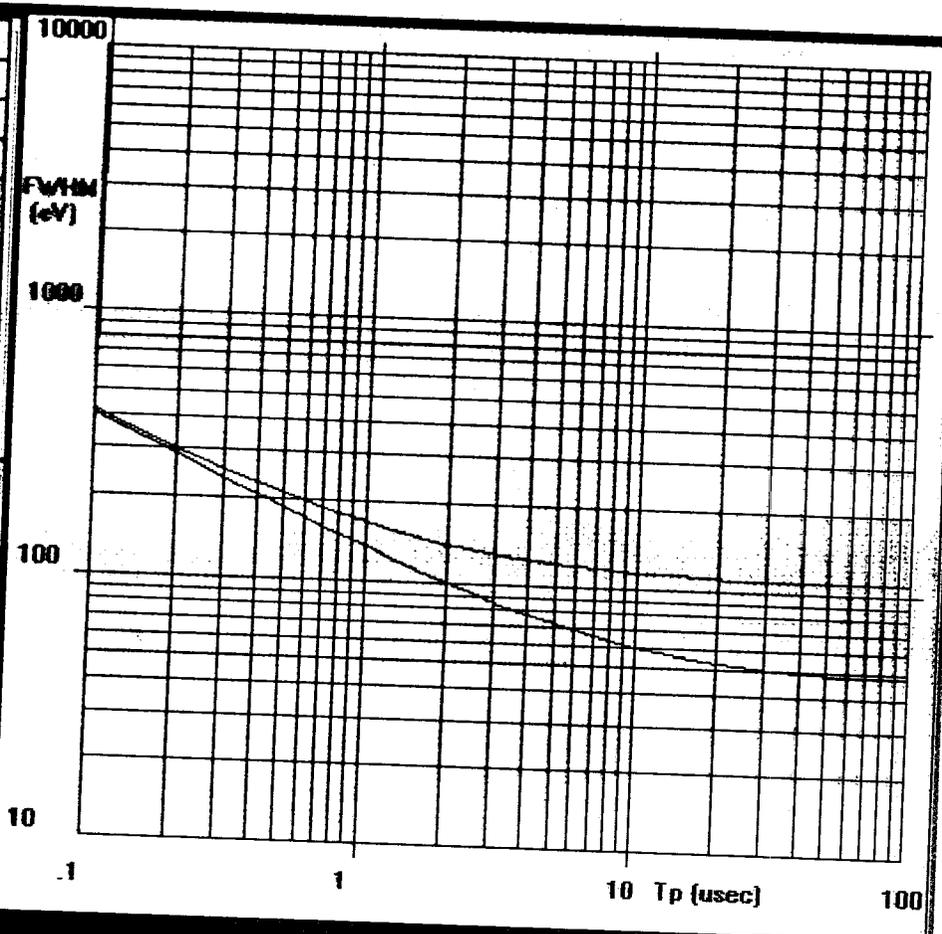
SAVE	PLOT	Insert
GET	PRINT	POINTS
BMPs	CLEAR	QUIT



**NOTE ON TEMPERATURE CONSIDERATIONS**  
 The temperature value is used to calculate noise in the parallel R and to set  $E_{g,0}$  for the detector material. FET noise has no predictable dependence. The value of  $G_m$  at the operating temperature should be used and 300K is assumed in the calculation.

Star Ge	Ge
Det C (pF)	3
Det I (pA)	.01
Fano Factor	12
Energy (keV)	5.89
FET Gain (A/V)	6
FET C (pF)	1.5
Serial R (Ohms)	10
Det. Time (K)	82
Paral. R (Mohms)	
A(I/A) x 1E-14	

- Shaper
- RC diff + n integ
  - Pseudo-Triangle
  - Parabolic Cusp
  - Flat-top Trapezoid
  - Sin. n Shaper
  - Gated Int (Sin<sup>n</sup>b)
  - User Defined



SAVE	PLOT	Insert
GET	PRINT	POINTS
MPs	CLEAR	QUIT

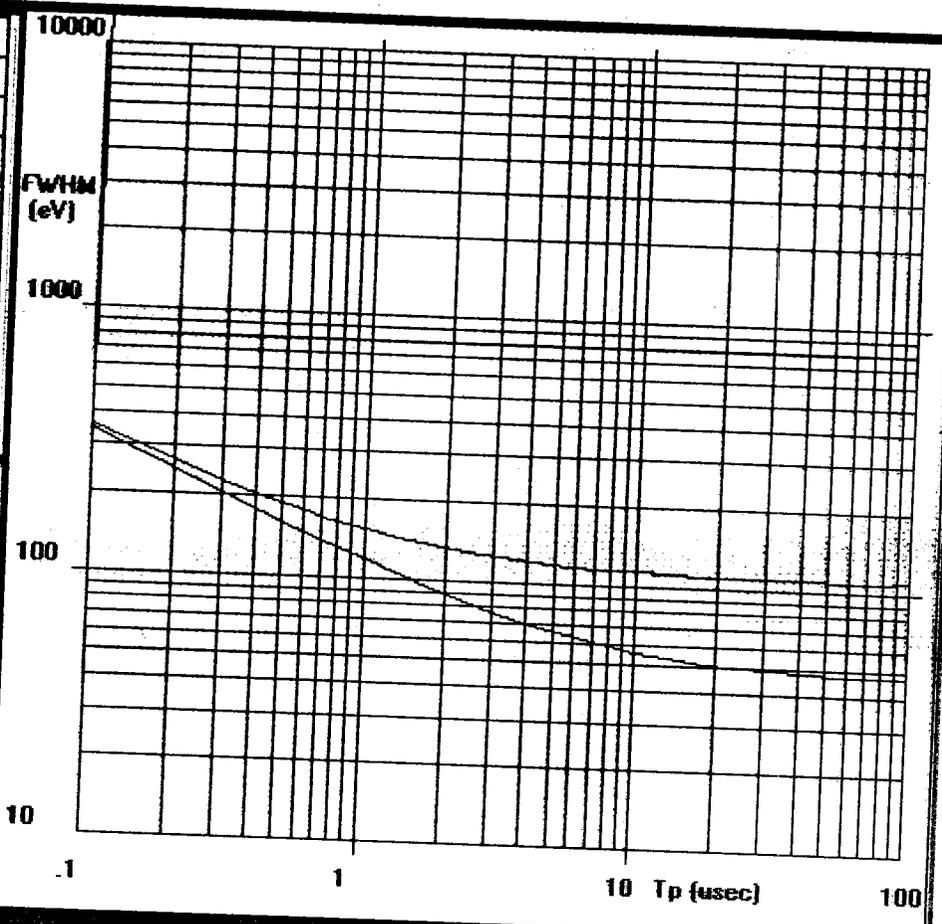
**NOTE ON TEMPERATURE CONSIDERATIONS**

The temperature value is used to calculate noise in the parallel R and to set Epsilon for the detector material. FET noise has no predictable dependence. The value of I<sub>on</sub> at the operating temperature should be used and 300K is assumed in the calculation.

Sim Ge	Ge
Det (pF)	.3
Det I (pA)	.01
Gain Factor	.12
Energy (keV)	5.89
FET Gain (V)	3
FET (dB)	.8
Source R (ohms)	10
Det Time (K)	82
Parallel R (ohms)	
A(LA) = 1E-14	

- Shaper
- RC 2nd + n integ
  - Pseudo-Triangle
  - Parabolic Top
  - Flat Top / Tapered
  - Sin  $\pi$  Shaper
  - Gated Int (Sin<sup>2</sup> G)
  - User Defined

AVE	PLOT	Insert
GET	PRINT	POINTS
MP:	CLEAR	QUIT

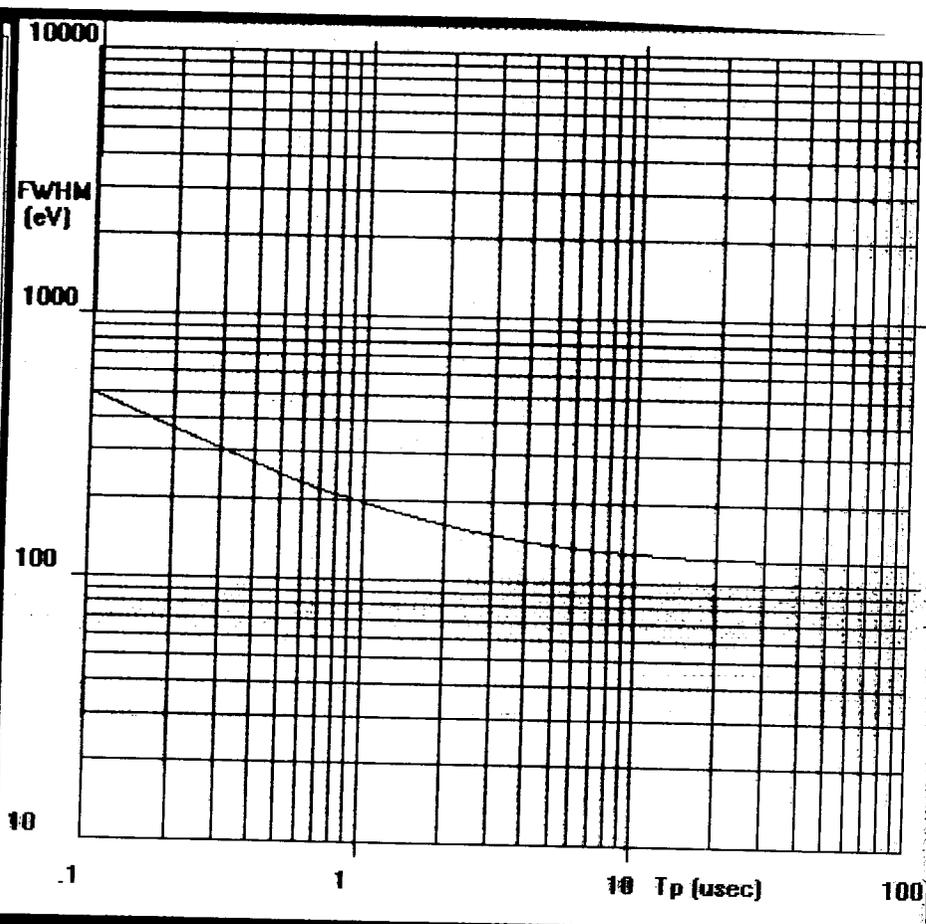


**NOTE ON TEMPERATURE CONSIDERATIONS**  
 The temperature value is used to calculate noise in the parallel R and to set Epsilon for the detector material. FET noise has no predictable dependence. The value of Ge at the operating temperature should be used and 300K is assumed in the calculation.

Material	Si
FWHM (eV)	.3
Gain (mV)	0.01
Gain (V)	.12
Gain (mV)	5.89
Gain (V)	6
Gain (mV)	1.5
Gain (V)	10
Gain (mV)	300

- Shaper
- Gaussian
  - Parabolic
  - Trapezoidal
  - Parabolic
  - Trapezoidal
  - Parabolic
  - Trapezoidal

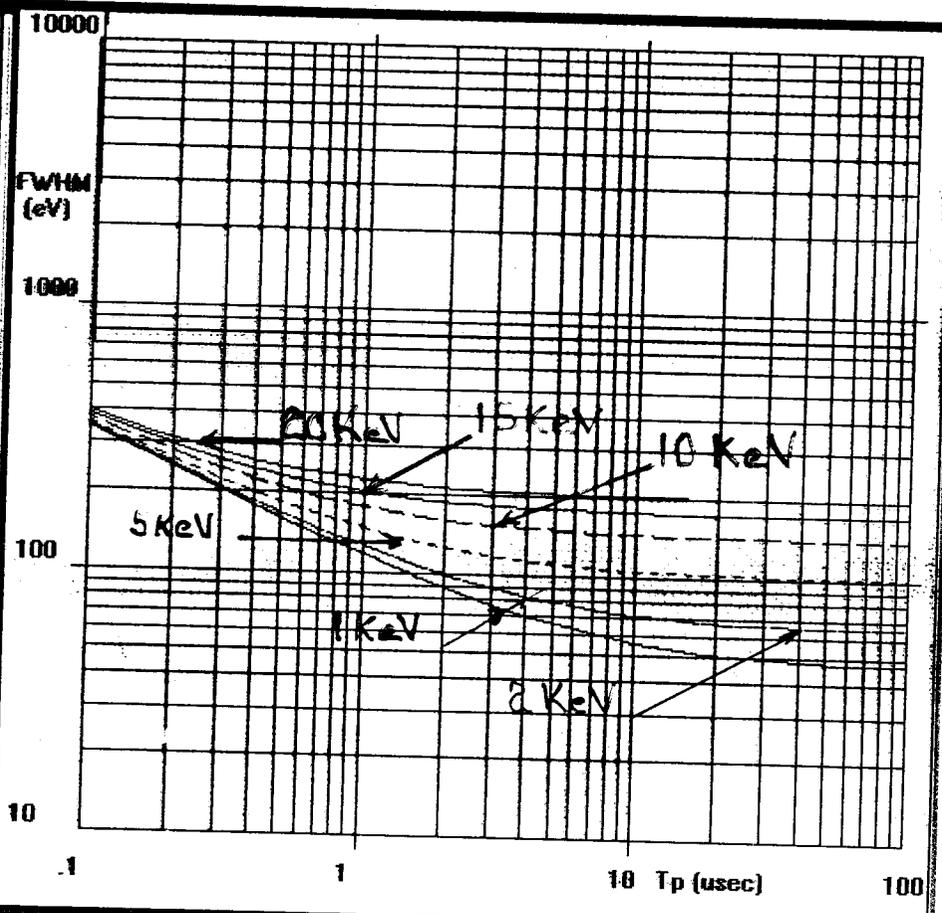
Gain	0.01	0.01
Gain	0.01	0.01
Gain	0.01	0.01



**NOTE ON TEMPERATURE CONSIDERATIONS**

Temperature variations can affect the performance of the detector. The FWHM is a function of temperature and should be used as a guide to the detector's performance. The FWHM is a function of temperature and should be used as a guide to the detector's performance.

Si or Ge	Ge
Det (pF)	.3
Det (pA)	.01
Fano Factor	.12
Energy (KeV)	20
FET Gain (V)	3
FET CMR	.8
Source R (Ohms)	10
Det Time (ns)	82
Paral R (Mohms)	
A(1/f) = 1E-14	



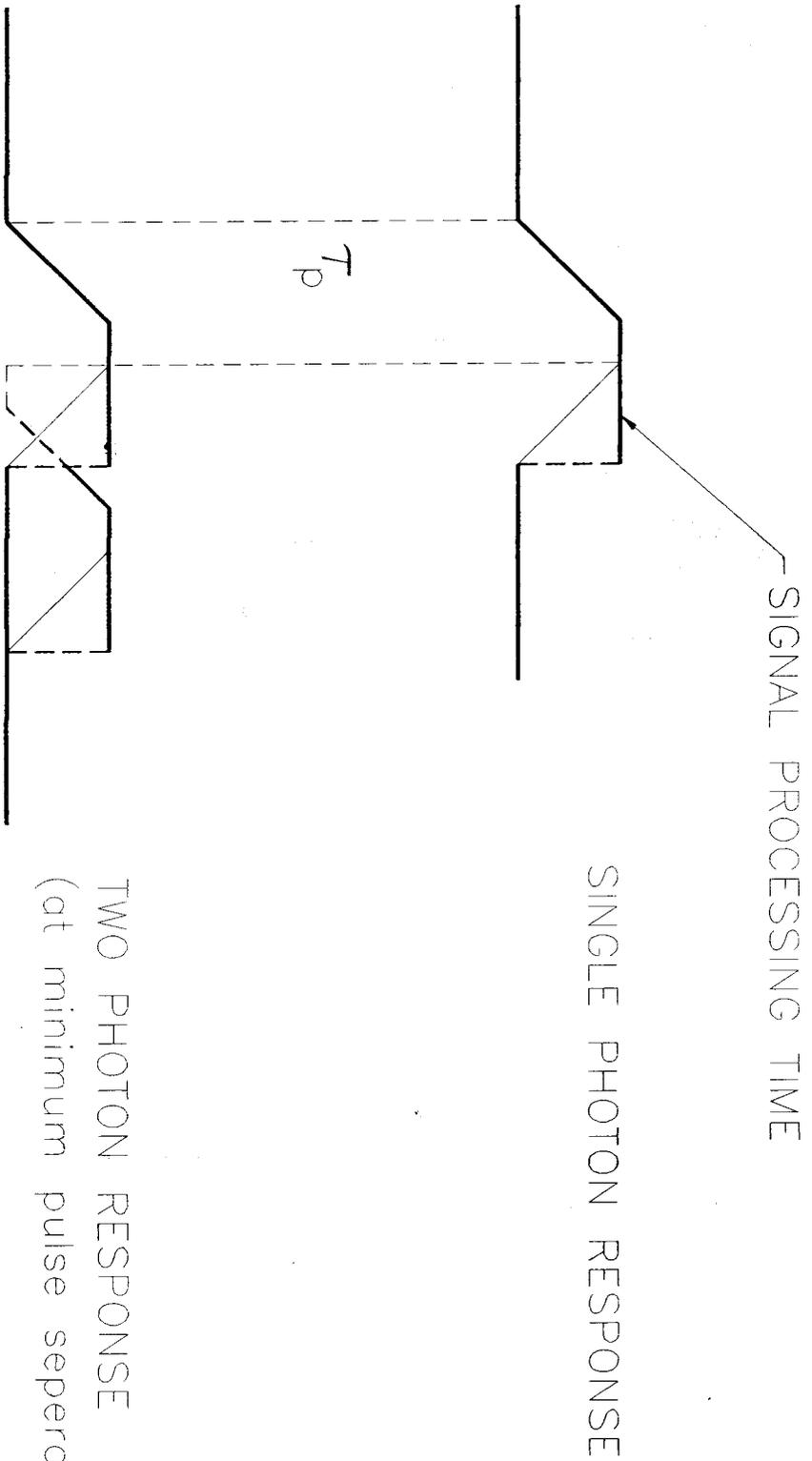
- Shaper
- RC (n) + n integ
  - Pseudo-Triangle
  - Karnath Crisp
  - Flat Top Trapezoid
  - Sin<sup>2</sup> Shaper
  - Gated Int (Sin<sup>2</sup>)
  - User Defined

SAVE	PLOT	Insert
GET	PRINT	POINTS
BMPs	CLEAR	QUIT

**NOTE ON TEMPERATURE CONSIDERATIONS**

The temperature value is used to calculate noise in the parallel R and to get  $E_{noise}$  for the detector material. FET noise has no predictable dependence. The value of  $f_{1/f}$  in the operating temperature should be used and 300K is assumed in the calculation.

# IDEAL HIGH RATE SIGNAL PROCESSING



SIGNAL PROCESSING TIME

TWO PHOTON RESPONSE  
(at minimum pulse separation)

